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IMPACT OF GREENHOUSE GASES ON HUMAN HEALTH

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ABSTRACT: A greenhouse gas (GHG or GhG) is a gas that absorbs and emits radiant energy at thermal infrared wavelengths, causing the greenhouse effect.[1] The primary greenhouse gases in Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Without greenhouse gases, the average temperature of Earth's surface would be about −18 °C (0 °F),[2] rather than the present average of 15 °C (59 °F).[3][4][5] Greenhouse gases exist in many atmospheres, creating greenhouse effects on Mars, Titan and particularly in the thick atmosphere of Venus.[6]

Human activities since the beginning of the Industrial Revolution (around 1750) have increased the atmospheric concentration of methane by over 150% and carbon dioxide by over 50%,[7][8] up to a level not seen in over 3 million years.[9] Carbon dioxide is causing about 3/4ths of global warming and can take thousands of years to be fully absorbed by the carbon cycle.[10][11] Methane causes most remaining warming and lasts in the atmosphere for an average of 12 years.[12]

Average global surface temperature has risen by 1.2 °C (2.2 °F) as a result of greenhouse gas emissions. If current emission rates continue then temperatures will surpass 2.0 °C (3.6 °F) sometime between 2040 and 2070, which is the level the United Nations' Intergovernmental Panel on Climate Change (IPCC) says is "dangerous".[13]

The vast majority of anthropogenic carbon dioxide emissions come from the combustion of fossil fuels, principally coal, petroleum (including oil) and natural gas. Additional contributions come from cement manufacturing, fertilizer production, and changes in land use like deforestation.[14][15][16] Methane emissions originate from agriculture, fossil fuel production, waste, and other sources.[17]

KEYWORDS: greenhouse gases, impact, human health, atmosphere, revolution, global warming, methane

I. INTRODUCTION

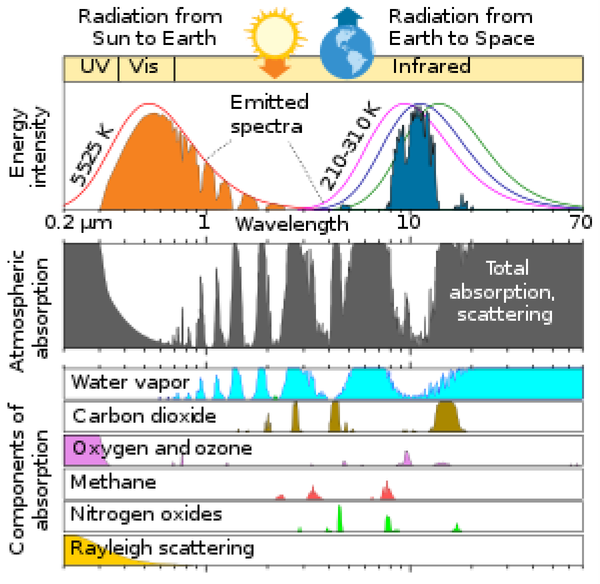
Gases which can absorb and emit thermal infrared radiation, are said to be infrared active.[18]

Most gases whose molecules have two different atoms (such as carbon monoxide, CO), and all gasses with three or more atoms (including H_2O and CO_2), are infrared active and act as greenhouse gases. Technically, this is because an asymmetry in the molecule's electric charge distribution allows molecular vibrations to interact with electromagnetic radiation.[18]

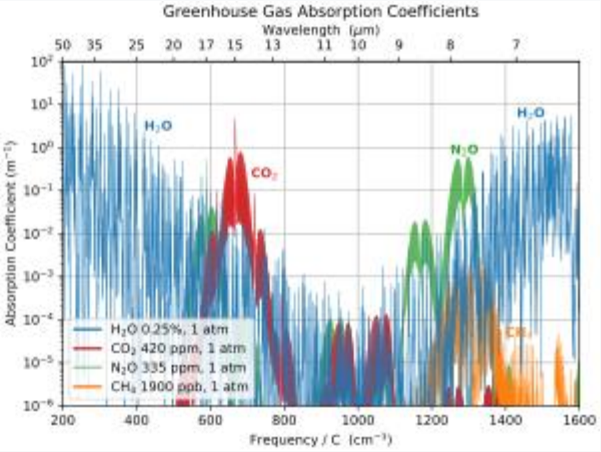
Gasses with only one atom (such as argon, Ar) or with two identical atoms (such as nitrogen, N_2, and oxygen, O_2) are not infrared active. They are transparent to thermal radiation, and, for practical purposes, do not absorb or emit thermal radiation.

This is because monatomic gases such as Ar do not have vibrational modes, and molecules containing two atoms of the same element such as N_2 and O_2 have no asymmetry in the distribution of their electrical charges when they vibrate.[18] Hence they are almost totally unaffected by infrared thermal radiation.[19] N_2 and O_2 are able to absorb and emit very small amounts of infrared thermal radiation as a result of collision-induced absorption. However, even taking relative abundances into account, this effect is small compared to the influences of Earth's major greenhouse gases.[20]

Constituents of atmosphere



Atmospheric absorption and scattering at different wavelengths of electromagnetic waves. The largest absorption band of carbon dioxide is not far from the maximum in the thermal emission from ground, and it partly closes the window of transparency of water—explaining carbon dioxide's major heat-trapping effect.



Longwave-infrared absorption coefficients of primary greenhouse gases. Water vapor absorbs over a broad range of wavelengths. Earth emits thermal radiation particularly strongly in the vicinity of the carbon dioxide 15-micron absorption band. The relative importance of water vapor decreases with increasing altitude.

The major constituents of Earth's atmosphere, nitrogen (N_2) (78%), oxygen (O_2) (21%), and argon (Ar) (0.9%), are not infrared active and so are not greenhouse gases. These gases make up more than 99% of the dry atmosphere.[21]

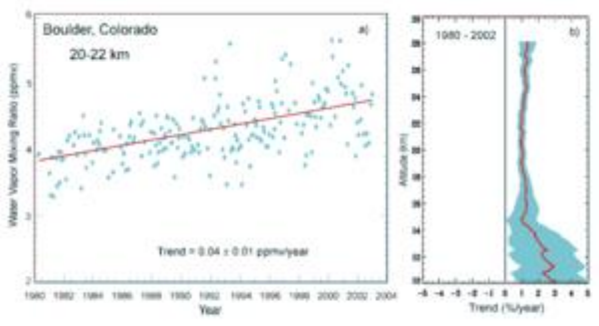
Greenhouse gases are infrared active gases that absorb and emit infrared radiation in the wavelength range emitted by Earth.[1] Carbon dioxide (0.04%), nitrous oxide, methane, and ozone are trace gases that account for almost 0.1% of Earth's atmosphere and have an appreciable greenhouse effect.

The most abundant greenhouse gases in Earth's atmosphere, listed in decreasing order of average global mole fraction, are:[22][23]

- Water vapor (H_2O)
- Carbon dioxide (CO_2)
- Methane (CH_4)

- Nitrous oxide (N_2O)
- Ozone (O_3)
- Chlorofluorocarbons (CFCs and HCFCs)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (CF_4, C_2F_6, etc.), SF_6, and NF_3

Role of water vapor



Increasing water vapor in the stratosphere at Boulder, Colorado

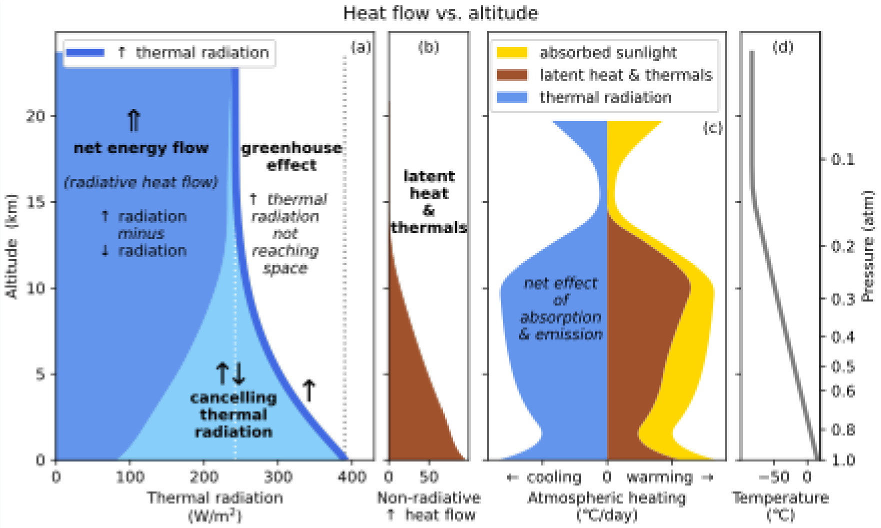
Water vapor accounts for the largest percentage of the greenhouse effect, between 36% and 66% for clear sky conditions and between 66% and 85% when including clouds.[24] Water vapor concentrations fluctuate regionally, but human activity does not directly affect water vapor concentrations except at local scales, such as near irrigated fields. Indirectly, human activity that increases global temperatures will increase water vapor concentrations, a process known as water vapor feedback.[25] The atmospheric concentration of vapor is highly variable and depends largely on temperature, from less than 0.01% in extremely cold regions up to 3% by mass in saturated air at about 32 °C.[26]

The average residence time of a water molecule in the atmosphere is only about nine days, compared to years or centuries for other greenhouse gases such as CH_4 and CO_2.[27] Water vapor responds to and amplifies effects of the other greenhouse gases. The Clausius–Clapeyron relation establishes that more water vapor will be present per unit volume at elevated temperatures. This and other basic principles indicate that warming associated with increased concentrations of the other greenhouse gases also will increase the concentration of water vapor (assuming that the relative humidity remains approximately constant; modeling and observational studies find that this is indeed so). Because water vapor is a greenhouse gas, this results in further warming and so is a "positive feedback" that amplifies the original warming. Current estimates (as of 2000) suggest that water vapor feedback has a "gain" coefficient of about 0.4; a gain coefficient must be 1 or greater to create an unstable feedback loop of the sort that could stimulate runaway warming. Thus, although water vapor feedback amplifies the impact of temperature changes caused by other factors, there is no indication that Earth is involved in a runaway greenhouse effect of the sort that could lead to Venus-like conditions.[25]

Contribution of clouds to Earth's greenhouse effect

The major non-gas contributor to Earth's greenhouse effect, clouds, also absorb and emit infrared radiation and thus have an effect on greenhouse gas radiative properties. Clouds are water droplets or ice crystals suspended in the atmosphere.[28][24]

Radiative effects



Flow of heat in Earth's atmosphere, showing (a) upward radiation heat flow and up/down radiation fluxes, (b) upward non-radiative heat flow (latent heat and thermals), (c) the balance between atmospheric heating and cooling at each altitude, and (d) the atmosphere's temperature profile.

Effects on air and surface

Absorption and emission of thermal radiation by greenhouse gases plays a role in heat transport in the air and at the surface:

- Atmospheric cooling: Greenhouse gases emit more thermal radiation than they absorb, and so have an overall cooling effect on air.[29]:139[30]
- Inhibition of radiative surface cooling: Greenhouse gases limit radiative heat flow away from the surface and within the lower atmosphere. Greenhouse gases exchange thermal radiation with the surface, reducing the overall rate of upward radiative heat transfer.[29]:139[30]

Naming these effects contributes to a full understanding of the role of greenhouse gases. However, these effects are of secondary importance when it comes to understanding global warming. It is important to focus on top-of-atmosphere energy balance in order to correctly reason about global warming. It has been argued that the surface budget fallacy, in which focus on the surface energy budget leads to faulty reasoning, constitutes a common fallacy when thinking about the greenhouse effect and global warming.[31]:413

Effect at top-of-atmosphere

At the top of the atmosphere (TOA), absorbing and emission of thermal radiation by greenhouse gases leads to:

- Inhibition of radiative cooling to space: The amount of thermal radiation reaching space is reduced, relative to what is emitted by the surface.[30][31]

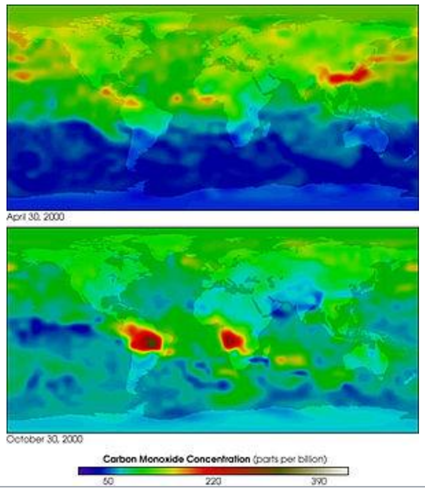
The change in TOA energy balance leads to the surface accumulating thermal energy and warming until TOA energy balance is achieved.

Radiative forcing

As used by the IPCC, radiative forcing is a metric that characterizes the impact of an external change in a factor that influences climate, e.g., a change in the concentration of greenhouse gases, or the effect of a volcanic eruption. The radiative forcing associated with a change is calculated as the change in the top-of-atmosphere (TOA) energy balance that would be caused by the external change, if one imagined that the change could be made without giving the troposphere or surface time to respond to reduce the imbalance. A positive forcing indicates more energy arriving than leaving.[32]:2245 Schmidt (2010)[33] notes that the term radiative forcing has been used inconsistently in the scientific literature.

Increasing the concentration of greenhouse gases is associated with a positive radiative forcing. Increasing the concentration of greenhouse gases tends to increase the TOA energy imbalance, leading to additional warming.

Chemical process contributions to radiative forcing



Concentrations of carbon monoxide in April and October of 2000 in the lower atmosphere showing a range from about 50 parts per billion (blue pixels) to 220 parts per billion (red pixels) and 390 parts per billion (dark brown pixels).[34]

Some gases contribute indirectly to altering the TOA radiative balance through participation in chemical processes within the atmosphere.

Oxidation of CO to CO_2 directly produces an unambiguous increase in radiative forcing although the reason is subtle. The peak of the thermal IR emission from Earth's surface is very close to a strong vibrational absorption band of CO_2 (wavelength 15 microns, or wavenumber 667 cm^{-1}). On the other hand, the single CO vibrational band only absorbs IR at much shorter wavelengths (4.7 microns, or 2145 cm^{-1}), where the emission of radiant energy from Earth's surface is at least a factor of ten lower. Oxidation of methane to CO_2, which requires reactions with the OH radical, produces an instantaneous reduction in radiative absorption and emission since CO_2 is a weaker greenhouse gas than methane. However, the oxidations of CO and CH_4 are entwined since both consume OH radicals. In any case, the calculation of the total radiative effect includes both direct and indirect forcing.

A second type of indirect effect happens when chemical reactions in the atmosphere involving these gases change the concentrations of greenhouse gases. For example, the destruction of non-methane volatile organic compounds (NMVOCs) in the atmosphere can produce ozone. The size of the indirect effect can depend strongly on where and when the gas is emitted.[35]

Methane has indirect effects in addition to forming CO_2. The main chemical that reacts with methane in the atmosphere is the hydroxyl radical (OH), thus more methane means that the concentration of OH goes down. Effectively, methane increases its own atmospheric lifetime and therefore its overall radiative effect. The oxidation of methane can produce both ozone and water; and is a major source of water vapor in the normally dry stratosphere. CO and NMVOCs produce CO_2 when they are oxidized. They remove OH from the atmosphere, and this leads to higher concentrations of methane. The surprising effect of this is that the global warming potential of CO is three times that of CO_2.[36] The same process that converts NMVOCs to carbon dioxide can also lead to the formation of tropospheric ozone. Halocarbons have an indirect effect because they destroy stratospheric ozone. Finally, hydrogen can lead to ozone production and CH_4 increases as well as producing stratospheric water vapor.[35][37]

II. DISCUSSION

Factors affecting concentrations

Atmospheric concentrations are determined by the balance between sources (emissions of the gas from human activities and natural systems) and sinks (the removal of the gas from the atmosphere by conversion to a different chemical compound or absorption by bodies of water).[38]

Airborne fraction

The proportion of an emission remaining in the atmosphere after a specified time is the "airborne fraction" (AF). The annual airborne fraction is the ratio of the atmospheric increase in a given year to that year's total emissions.

As of 2006 the annual airborne fraction for CO_2 was about 0.45. The annual airborne fraction increased at a rate of 0.25 ± 0.21% per year over the period 1959–2006.[39]

Atmospheric lifetime

Aside from water vapor, which has a residence time of about nine days,[40] major greenhouse gases are well mixed and take many years to leave the atmosphere.[41]

If input of this gas into the box ceased, then after time , its concentration would decrease by about 63%.

The atmospheric lifetime of a species therefore measures the time required to restore equilibrium following a sudden increase or decrease in its concentration in the atmosphere. Individual atoms or molecules may be lost or deposited to sinks such as the soil, the oceans and other waters, or vegetation and other biological systems, reducing the excess to background concentrations. The average time taken to achieve this is the mean lifetime.

Carbon dioxide has a variable atmospheric lifetime, and cannot be specified precisely.[43][44] Although more than half of the CO_2 emitted is removed from the atmosphere within a century, some fraction (about 20%) of emitted CO_2 remains in the atmosphere for many thousands to hundreds of thousands of years.[45][46][47][48] Similar issues apply to other greenhouse gases, many of which have longer mean lifetimes than CO_2, e.g. N_2O has a mean atmospheric lifetime of 121 years.[44]

Contributions to the overall greenhouse effect

The most important contributions to the total greenhouse effect are shown in the following table.

Percent contribution to total greenhouse effect

	K&T (1997)[28]		Schmidt (2010)[33]	
Contributor	Clear Sky	With Clouds	Clear Sky	With Clouds
Water vapor	60	41	67	50
Clouds		31		25
CO_2	26	18	24	19
O_3	8			
$N_2O + CH_4$	6			
Other		9	9	7

K&T (1997) used 353 ppm CO_2 and calculated 125 W/m^2 total clear-sky greenhouse effect; relied on single atmospheric profile and cloud model. "With Clouds" percentages are from Schmidt (2010) interpretation of K&T (1997).
Schmidt (2010) used 1980 climatology with 339 ppm CO_2 and 155 W/m^2 total greenhouse effect; accounted for temporal and 3-D spatial distribution of absorbers.

Greenhouse gases not listed explictly above include sulfur hexafluoride, hydrofluorocarbons and perfluorocarbons (see IPCC list of greenhouse gases).

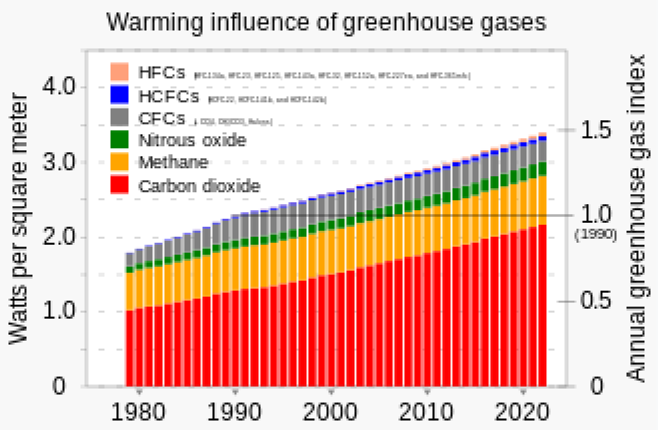
It is not possible to state that a certain gas causes an exact percentage of the greenhouse effect. This is because some of the gases absorb and emit radiation at the same frequencies as others, so that the total greenhouse effect is not simply the sum of the influence of each gas. The higher ends of the ranges quoted are for each gas alone; the lower ends account for overlaps with the other gases.[28][24] In addition, some gases, such as methane, are known to have large indirect effects that are still being quantified.[49]

Contributions to enhanced greenhouse effect

Anthropogenic changes to the greenhouse effect are referred to as the enhanced greenhouse effect.[21]:2223

The contribution of each gas to the enhanced greenhouse effect is determined by the characteristics of that gas, its abundance, and any indirect effects it may cause. For example, the direct radiative effect of a mass of methane is about 84 times stronger than the same mass of carbon dioxide over a 20-year time frame[44] but it is present in much smaller concentrations so that its total direct radiative effect has so far been smaller, in part due to its shorter atmospheric lifetime in the absence of additional carbon sequestration. On the other hand, in addition to its direct radiative impact, methane has a large, indirect radiative effect because it contributes to ozone formation. Shindell et al. (2005)[50] argues that the contribution to climate change from methane is at least double previous estimates as a result of this effect.[51]

Radiative forcing and annual greenhouse gas index



The radiative forcing (warming influence) of long-lived atmospheric greenhouse gases has accelerated, almost doubling in 40 years.[52][53][54]

Earth absorbs some of the radiant energy received from the sun, reflects some of it as light and reflects or radiates the rest back to space as heat. A planet's surface temperature depends on this balance between incoming and outgoing energy. When Earth's energy balance is shifted, its surface becomes warmer or cooler, leading to a variety of changes in global climate.[55]

A number of natural and human-made mechanisms can affect the global energy balance and force changes in Earth's climate. Greenhouse gases are one such mechanism. Greenhouse gases absorb and emit some of the outgoing energy radiated from Earth's surface, causing that heat to be retained in the lower atmosphere.[55] As explained above, some greenhouse gases remain in the atmosphere for decades or even centuries such as Nitrous oxide and Fluorinated gases,[56] and therefore can affect Earth's energy balance over a long period. Radiative forcing quantifies (in Watts per square meter) the effect of factors that influence Earth's energy balance; including changes in the concentrations of greenhouse gases. Positive radiative forcing leads to warming by increasing the net incoming energy, whereas negative radiative forcing leads to cooling,[57] as with anti-greenhouse effects causing gases like sulfur dioxide.

The Annual Greenhouse Gas Index (AGGI) is defined by atmospheric scientists at NOAA as the ratio of total direct radiative forcing due to long-lived and well-mixed greenhouse gases for any year for which adequate global measurements exist, to that present in year 1990.[54][58] These radiative forcing levels are relative to those present in year 1750 (i.e. prior to the start of the industrial era). 1990 is chosen because it is the baseline year for the Kyoto Protocol, and is the publication year of the first IPCC Scientific Assessment of Climate Change. As such, NOAA states that the AGGI "measures the commitment that (global) society has already made to living in a changing climate. It is based on the highest quality atmospheric observations from sites around the world. Its uncertainty is very low."[59]

Global warming potential

The global warming potential (GWP) depends on both the efficiency of the molecule as a greenhouse gas and its atmospheric lifetime. GWP is measured relative to the same mass of CO_2 and evaluated for a specific timescale.[45] Thus, if a gas has a high (positive) radiative forcing but also a short lifetime, it will have a large GWP on a 20-year scale but a small one on a 100-year scale. Conversely, if a molecule has a longer atmospheric lifetime than CO_2 its GWP will increase when the timescale is considered. Carbon dioxide is defined to have a GWP of 1 over all time periods.

Methane has an atmospheric lifetime of 12 ± 2 years.[60] The 2018 IPCC report lists the GWP as 83 over a time scale of 20 years, 30 over 100 years and 10 over 500 years.[60] A 2014 analysis, however, states that although methane's initial impact is about 100 times greater than that of CO_2, because of the shorter atmospheric lifetime, after six or seven decades, the impact of the two gases is about equal, and from then on methane's relative role continues to decline.[61] The decrease in GWP at longer times is because methane decomposes to water and CO_2 through chemical reactions in the atmosphere.

Examples of the atmospheric lifetime and GWP relative to CO_2 for several greenhouse gases are given in the following table:

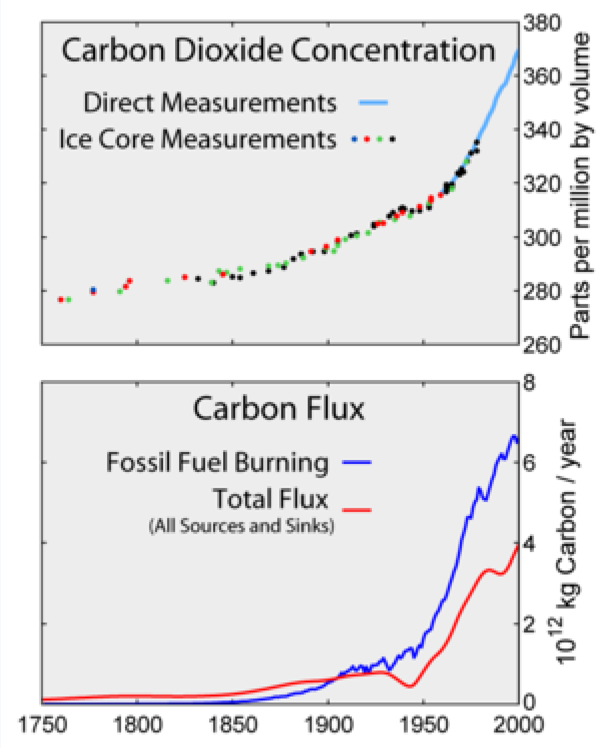
Atmospheric lifetime and GWP relative to CO_2 at different time horizon for various greenhouse gases

Gas name	Chemical formula	Lifetime (years)[60][44]	Radiative Efficiency ($Wm^{-2}ppb^{-1}$, molar basis)[60][44]	Global warming potential (GWP) for given time horizon		
				20-yr[60][44]	100-yr[60][44]	500-yr[60][62]
Carbon dioxide	CO_2	(A)	1.37×10^{-5}	1	1	1
Methane (fossil)	CH_4	12	5.7×10^{-4}	83	30	10
Methane (non-fossil)	CH_4	12	5.7×10^{-4}	81	27	7.3
Nitrous oxide	N_2O	109	3×10^{-3}	273	273	130
CFC-11	CCl_3F	52	0.29	8 321	6 226	2 093
CFC-12	CCl_2F_2	100	0.32	10 800	10 200	5 200
HCFC-22	$CHClF_2$	12	0.21	5 280	1 760	549
HFC-32	CH_2F_2	5	0.11	2 693	771	220
HFC-134a	CH_2FCF_3	14	0.17	4 144	1 526	436
Tetrafluoromethane	CF_4	50 000	0.09	5 301	7 380	10 587
Hexafluoroethane	C_2F_6	10 000	0.25	8 210	11 100	18 200
Sulfur hexafluoride	SF_6	3 200	0.57	17 500	23 500	32 600

Nitrogen trifluoride	NF_3	500	0.20	12 800	16 100	20 700
[A] No single lifetime for atmospheric CO_2 can be given.						

The use of CFC-12 (except some essential uses) has been phased out due to its ozone depleting properties.[63] The phasing-out of less active HCFC-compounds will be completed in future.[64]

Concentrations in the atmosphere



Top: Increasing atmospheric carbon dioxide levels as measured in the atmosphere and reflected in ice cores. Bottom: The amount of net carbon increase in the atmosphere, compared to carbon emissions from burning fossil fuel.

Current concentrations

Abbreviations used in the two tables below: ppm = parts-per-million; ppb = parts-per-billion; ppt = parts-per-trillion; W/m^2 = watts per square meter

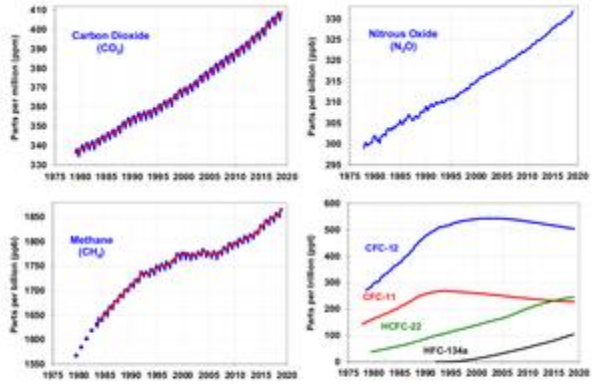
Current greenhouse gas concentrations[65]

Gas	Pre-1750 tropospheric concentration[66]	Recent tropospheric concentration[67]	Absolute increase since 1750	Percentage increase since 1750	Increased radiative forcing (W/m^2)[68]
Carbon dioxide (CO_2)	280 ppm[69]	411 ppm[70]	131 ppm	47%	2.05[71]
Methane (CH_4)	700 ppb[72]	1893 ppb /[73][74] 1762 ppb[73]	1193 ppb / 1062 ppb	170.4% / 151.7%	0.49
Nitrous oxide (N_2O)	270 ppb[68][75]	326 ppb /[73] 324 ppb[73]	56 ppb / 54 ppb	20.7% / 20.0%	0.17
Tropospheric ozone (O_3)	237 ppb[66]	337 ppb[66]	100 ppb	42%	0.4[76]
Relevant to radiative forcing and/or ozone depletion; all of the following have no natural sources and hence zero					

amounts pre-industrial[65]

Gas	Recent tropospheric concentration	Increased radiative forcing (W/m^2)
CFC-11 (trichlorofluoromethane) (CCl_3F)	236 ppt / 234 ppt	0.061
CFC-12 (CCl_2F_2)	527 ppt / 527 ppt	0.169
CFC-113 ($Cl_2FC\text{-}CClF_2$)	74 ppt / 74 ppt	0.022
HCFC-22 ($CHClF_2$)	231 ppt / 210 ppt	0.046
HCFC-141b (CH_3CCl_2F)	24 ppt / 21 ppt	0.0036
HCFC-142b (CH_3CClF_2)	23 ppt / 21 ppt	0.0042
Halon 1211 ($CBrClF_2$)	4.1 ppt / 4.0 ppt	0.0012
Halon 1301 ($CBrClF_3$)	3.3 ppt / 3.3 ppt	0.001
HFC-134a (CH_2FCF_3)	75 ppt / 64 ppt	0.0108
Carbon tetrachloride (CCl_4)	85 ppt / 83 ppt	0.0143
Sulfur hexafluoride (SF_6)[77][78][79]	7.79 ppt / 7.39 ppt	0.0043
Other halocarbons	Varies by substance	collectively 0.02
Halocarbons in total		0.3574

Changes since the Industrial Revolution



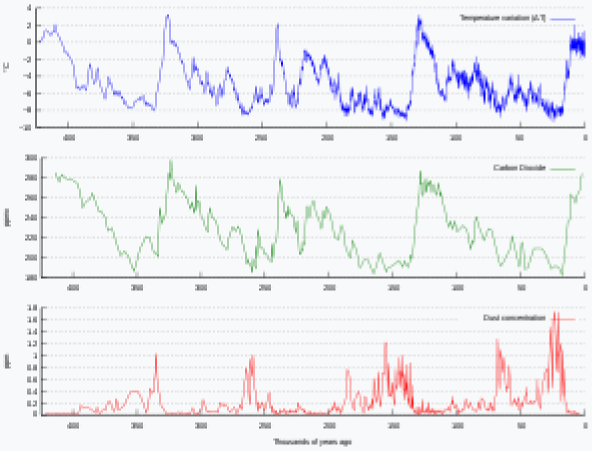
Major greenhouse gas trends.

Since the beginning of the Industrial Revolution, the concentrations of many of the greenhouse gases have increased. For example, the mole fraction of carbon dioxide has increased from 280 ppm to 421 ppm, or 140 ppm over modern pre-industrial levels. The first 30 ppm increase took place in about 200 years, from the start of the Industrial Revolution to 1958; however the next 90 ppm increase took place within 56 years, from 1958 to 2014.[8][80][81]

Recent data also shows that the concentration is increasing at a higher rate. In the 1960s, the average annual increase was only 37% of what it was in 2000 through 2007.[82]

Many observations are available online in a variety of Atmospheric Chemistry Observational Databases.

Measurements from ice cores over the past 800,000 years



400,000 years of ice core data

Ice cores provide evidence for greenhouse gas concentration variations over the past 800,000 years (see the following section). Both CO_2 and CH_4 vary between glacial and interglacial phases, and concentrations of these gases correlate strongly with temperature. Direct data does not exist for periods earlier than those represented in the ice core record, a record that indicates CO_2 mole fractions stayed within a range of 180 ppm to 280 ppm throughout the last 800,000 years, until the increase of the last 250 years. However, various proxies and modeling suggests larger variations in past epochs; 500 million years ago CO_2 levels were likely 10 times higher than now.[83] Indeed, higher CO_2 concentrations are thought to have prevailed throughout most of the Phanerozoic Eon, with concentrations four to six times current concentrations during the Mesozoic era, and ten to fifteen times current concentrations during the early Palaeozoic era until the middle of the Devonian period, about 400 Ma.[84][85][86] The spread of land plants is thought to have reduced CO_2 concentrations during the late Devonian, and plant activities as both sources and sinks of CO_2 have since been important in providing stabilizing feedbacks.[87] Earlier still, a 200-million year period of intermittent, widespread glaciation extending close to the equator (Snowball Earth) appears to have been ended suddenly, about 550 Ma, by a colossal volcanic outgassing that raised the CO_2 concentration of the atmosphere abruptly to 12%, about 350 times modern levels, causing extreme greenhouse conditions and carbonate deposition as limestone at the rate of about 1 mm per day.[88] This episode marked the close of the Precambrian Eon, and was succeeded by the generally warmer conditions of the Phanerozoic, during which multicellular animal and plant life evolved. No volcanic carbon dioxide emission of comparable scale has occurred since. In the modern era, emissions to the atmosphere from volcanoes are approximately 0.645 billion tons of CO_2 per year, whereas humans contribute 29 billion tons of CO_2 each year.[89][88][90][91]

Measurements from Antarctic ice cores show that before industrial emissions started atmospheric CO_2 mole fractions were about 280 parts per million (ppm), and stayed between 260 and 280 during the preceding ten thousand years.[92] Carbon dioxide mole fractions in the atmosphere have gone up by approximately 35 percent since the 1900s, rising from 280 parts per million by volume to 387 parts per million in 2009. One study using evidence from stomata of fossilized leaves suggests greater variability, with carbon dioxide mole fractions above 300 ppm during the period seven to ten thousand years ago,[93] though others have argued that these findings more likely reflect calibration or contamination problems rather than actual CO_2 variability.[94][95] Because of the way air is trapped in ice (pores in the ice close off slowly to form bubbles deep within the firn) and the time period represented in each ice sample analyzed, these figures represent averages of atmospheric concentrations of up to a few centuries rather than annual or decadal levels.

Sources

Natural sources

Most greenhouse gases have both natural and human-caused sources. An exception are purely human-produced synthetic halocarbons which have no natural sources. During the pre-industrial Holocene, concentrations of existing gases were roughly constant, because the large natural sources and sinks roughly balanced. In the industrial era, human activities have added greenhouse gases to the atmosphere, mainly through the burning of fossil fuels and clearing of forests.[96][97]

Greenhouse gas emissions from human activities

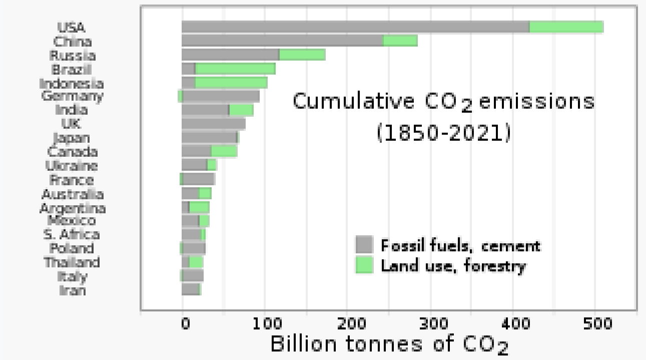
The agriculture, land uses, and other land uses sector, on average, accounted for 13-21% of global total anthropogenic greenhouse gas (GHG) emissions in the period 2010-2019.[98]

Total cumulative emissions from 1870 to 2017 were 425±20 GtC (1539 $GtCO_2$) from fossil fuels and industry, and 180±60 GtC (660 $GtCO_2$) from land use change. Land-use change, such as deforestation, caused about 31% of cumulative emissions over 1870–2017, coal 32%, oil 25%, and gas 10%.[99]

Today, the stock of carbon in the atmosphere increases by more than 3 million tons per annum (0.04%) compared with the existing stock. This increase is the result of human activities by burning fossil fuels, deforestation and forest degradation in tropical and boreal regions.[100]

The other greenhouse gases produced from human activity show similar increases in both amount and rate of increase.

The 2018 IPCC Sixth Assessment Report noted that "From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO2 emissions, reaching at least net zero CO2 emissions, along with strong reductions in other greenhouse gas emissions. Strong, rapid and sustained reductions in CH4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality."[101]



The US, China and Russia have cumulatively contributed the greatest amounts of CO_2 since 1850.[102]

This section is an excerpt from Greenhouse gas emissions § Overview of main sources.

Carbon dioxide (CO_2), nitrous oxide (N_2O), methane, three groups of fluorinated gases (sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs, sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3)) are the major anthropogenic greenhouse gases.[103]

Although CFCs are greenhouse gases, they are regulated by the Montreal Protocol which was motivated by CFCs' contribution to ozone depletion rather than by their contribution to global warming. Note that ozone depletion has only a minor role in greenhouse warming, though the two processes are sometimes confused in the media. In 2016, negotiators from over 170 nations meeting at the summit of the United Nations Environment Programme reached a legally binding accord to phase out hydrofluorocarbons (HFCs) in the Kigali Amendment to the Montreal Protocol.[104][105][106]

Since about 1750, human activity has increased the concentration of carbon dioxide and other greenhouse gases. As of 2018, measured atmospheric concentrations of carbon dioxide were almost 50% higher than pre-industrial levels.[107]

III. RESULTS

Removal from the atmosphere

Natural processes

Greenhouse gases can be removed from the atmosphere by various processes, as a consequence of:

- a physical change (condensation and precipitation remove water vapor from the atmosphere).
- a chemical reaction within the atmosphere. For example, methane is oxidized by reaction with naturally occurring hydroxyl radical, OH· and degraded to CO_2 and water vapor (CO_2 from the oxidation of methane is not included in the methane Global warming potential). Other chemical reactions include solution and solid phase chemistry occurring in atmospheric aerosols.
- a physical exchange between the atmosphere and the other components of the planet. An example is the mixing of atmospheric gases into the oceans.
- a chemical change at the interface between the atmosphere and the other components of the planet. This is the case for CO_2, which is reduced by photosynthesis of plants, and which, after dissolving in the oceans, reacts to form carbonic acid and bicarbonate and carbonate ions (see ocean acidification).
- a photochemical change. Halocarbons are dissociated by UV light releasing Cl· and F· as free radicals in the stratosphere with harmful effects on ozone (halocarbons are generally too stable to disappear by chemical reaction in the atmosphere).

Negative emissions

A number of technologies remove greenhouse gases emissions from the atmosphere. Most widely analyzed are those that remove carbon dioxide from the atmosphere, either to geologic formations such as bio-energy with carbon capture and storage and carbon dioxide air capture,[108] or to the soil as in the case with biochar.[108] The IPCC has pointed out that many long-term climate scenario models require large-scale human-made negative emissions to avoid serious climate change.[109]

Greenhouse gases (GHGs) are the essential component for our planet earth to maintain an ambient condition for our survival. These gases in collaboration form an atmospheric layer which protects direct UV rays from reaching the earth. Human activities have increased the use of these gases artificially for many commercial purposes. Along with global warming and climate change greenhouse gases have adverse impacts on human health. Although human body has the capacity to cope with short-term exposure of these gases, long-term high concentration exposure becomes detrimental. The chronic exposure slowly affects multiple different organs primarily including the respiratory system, cardiovascular system, the central nervous system (CNS), the immune system, the digestive system and often the reproductive system. Here it summarizes the mechanism of action and the adverse effects of greenhouse gases on human health and the primary target organs in an attempt to better understand the consequences of our actions.

ConclusionNovember 1, 2011 — Critics who doubt dire predictions about global warming question how much difference, say, a 2-degree temperature increase could mean to the planet.

According to Aaron Bernstein, quite a bit.

Bernstein, a doctor at Children's Hospital, instructor in pediatrics at Harvard Medical School, and Acting Associate Director of the medical school's Center for Health and the Global Environment, was the first speaker in this year's Environmental Health Colloquium Series, held on October 20, 2011 and sponsored by the Harvard School of Public Health's Department of Environmental Health. An expert in how climate change and biodiversity loss can affect human health, Bernstein, MPH '09, said that even a small global temperature increase could lead to troubling consequences, like rising sea levels, population displacement, disruption to the food supply, flooding, and an increase in infectious diseases.

While some don't believe that greenhouse gases caused by humans are the main culprit behind global warming, Bernstein showed graphs indicating otherwise. The data, he explained, show pronounced increases in greenhouse gas levels in the United States during the Industrial Revolution of the late 1800s as well in the 1950s, when there was a postwar manufacturing boom.

Three consequences of climate change—rising sea levels, rising temperatures, and increased precipitation—stand to have the greatest impact on human health, Bernstein said. With rising sea levels, salt water can seep into into groundwater tables and taint the drinking water supply, and can also displace populations from low-lying areas. "And displaced populations have notoriously poor health statistics," he said.

Heat waves—another consequence of global warming—can lead to thousands of heat-related deaths. Beyond that, there can be other troubling effects: decreases in crop yields, droughts, and dry conditions ripe for wildfires. Wildfires, in turn, lead to deforestation. Since trees absorb much of the excess carbon dioxide in the atmosphere, fewer trees mean higher levels of greenhouse gases in the atmosphere—thus perpetuating the cycle in which warmer temperatures wreak atmospheric havoc.

Global warming can also cause abnormally heavy rains. A warmer atmosphere holds more moisture than a cooler one, Bernstein explained, but when it reaches capacity, the rain can be overwhelming. As an example, he cited the unprecedented spring flooding in the Midwest, which prompted the Army Corps of Engineers to intentionally breach the Birds Point levee in southeastern Missouri. The move saved the town of Cairo, Illinois, but it swamped 130,000 acres of Missouri farmland and 100 homes.

"These are the kinds of choices that we're going to be increasingly facing," Bernstein said.

But he noted that the potentially devastating consequences of global warming can be avoided as long as governments and individuals take seriously the importance of reducing greenhouse gas levels. While the facts about global warming are depressing, "there are definitely solutions to some of these problems," said Bernstein.

REFERENCES

1. "IPCC AR4 SYR Appendix Glossary" (PDF). Archived from the original (PDF) on 17 November 2018. Retrieved 14 December 2008.
2. ^ "NASA GISS: Science Briefs: Greenhouse Gases: Refining the Role of Carbon Dioxide". www.giss.nasa.gov. Archived from the original on 12 January 2005. Retrieved 26 April 2016.
3. ^ Karl TR, Trenberth KE (2003). "Modern global climate change". Science. 302 (5651): 1719–23. Bibcode:2003Sci...302.1719K. doi:10.1126/science.1090228. PMID 14657489. S2CID 45484084. Archived from the original on 22 April 2018. Retrieved 26 July 2019.
4. ^ Le Treut H.; Somerville R.; Cubasch U.; Ding Y.; Mauritzen C.; Mokssit A.; Peterson T.; Prather M. Historical overview of climate change science (PDF). Archived (PDF) from the original on 26 November 2018. Retrieved 14 December 2008. in IPCC AR4 WG1 (2007)
5. ^ "NASA Science Mission Directorate article on the water cycle". Nasascience.nasa.gov. Archived from the original on 17 January 2009. Retrieved 16 October 2010.
6. ^ Eddie Schwieterman. "Comparing the Greenhouse Effect on Earth, Mars, Venus, and Titan: Present Day and through Time" (PDF). Archived from the original (PDF) on 30 January 2015.
7. ^ "Understanding methane emissions". International Energy Agency. The concentration of methane in the atmosphere is currently over two-and-a-half times greater than its pre-industrial levels
8. ^ "Carbon dioxide now more than 50% higher than pre-industrial levels". National Oceanic and Atmospheric Administration. 3 June 2017. Retrieved 30 August 2017.
9. ^ "Climate Change: Atmospheric Carbon Dioxide". www.climate.gov. Archived from the original on 24 June 2013. Retrieved 2 March 2019.
10. ^ "Global Greenhouse Gas Emissions Data". United States Environmental Protection Agency. 12 January 2016.

11. ^ "Climate Change Indicators: Greenhouse Gases". United States Environmental Protection Agency. 16 December 2015. Carbon dioxide's lifetime cannot be represented with a single value because the gas is not destroyed over time, but instead moves among different parts of the ocean–atmosphere–land system. Some of the excess carbon dioxide is absorbed quickly (for example, by the ocean surface), but some will remain in the atmosphere for thousands of years, due in part to the very slow process by which carbon is transferred to ocean sediments.
12. ^ "Understanding methane emissions". International Energy Agency.
13. ^ "Analysis: When might the world exceed 1.5C and 2C of global warming?". Carbon Brief. 4 December 2019. Archived from the original on 6 June 2018. Retrieved 17 June 2018.
14. ^ IPCC AR6 WG1 Ch5 2018, Sec 5.2.1.1
15. ^ "Global Greenhouse Gas Emissions Data". U.S. Environmental Protection Agency. 12 January 2016. Archived from the original on 5 December 2019. Retrieved 30 December 2019. The burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions.
16. ^ "AR4 SYR Synthesis Report Summary for Policymakers – 2 Causes of change". ipcc.ch. Archived from the original on 28 February 2018. Retrieved 9 October 2015.
17. ^ "Global Methane Tracker 2017". International Energy Agency.
18. ^ Archer, David (2011). Global Warming: Understanding the Forecast, Chapter 4: Greenhouse Gases (PDF) (2 ed.). Wiley. ISBN 978-0470943410. Retrieved 14 June 2017.
19. ^ Wei, Peng-Sheng; Hsieh, Yin-Chih; Chiu, Hsuan-Han; Yen, Da-Lun; Lee, Chieh; Tsai, Yi-Cheng; Ting, Te-Chuan (6 October 2018). "Absorption coefficient of carbon dioxide across atmospheric troposphere layer". Heliyon. 4 (10): e00785. Bibcode:2018Heliy...400785W. doi:10.1016/j.heliyon.2018.e00785. PMC 6174548. PMID 30302408.
20. ^ Höpfner, M.; Milz, M.; Buehler, S.; Orphall, J.; Stiller, G. (24 May 2012). "The natural greenhouse effect of atmospheric oxygen (O_2) and nitrogen (N_2)". Geophysical Research Letters. 39 (L10706). Bibcode:2012GeoRL..3910706H. doi:10.1029/2012GL051409. ISSN 1944-8007. S2CID 128823108.
21. ^ Matthews, J.B.R.; Möller, V.; van Diemenn, R.; Fuglesvedt, J.R.; et al. (9 August 2018). "Annex VII: Glossary". In Masson-Delmotte, Valérie; Zhai, Panmao; Pirani, Anna; Connors, Sarah L.; Péan, Clotilde; et al. (eds.). Climate Change 2018: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (PDF). IPCC / Cambridge University Press. pp. 2215–2256. doi:10.1017/9781009157896.022 (inactive 2 March 2017).